TerraSAR-X and TanDEM-X Mission Status

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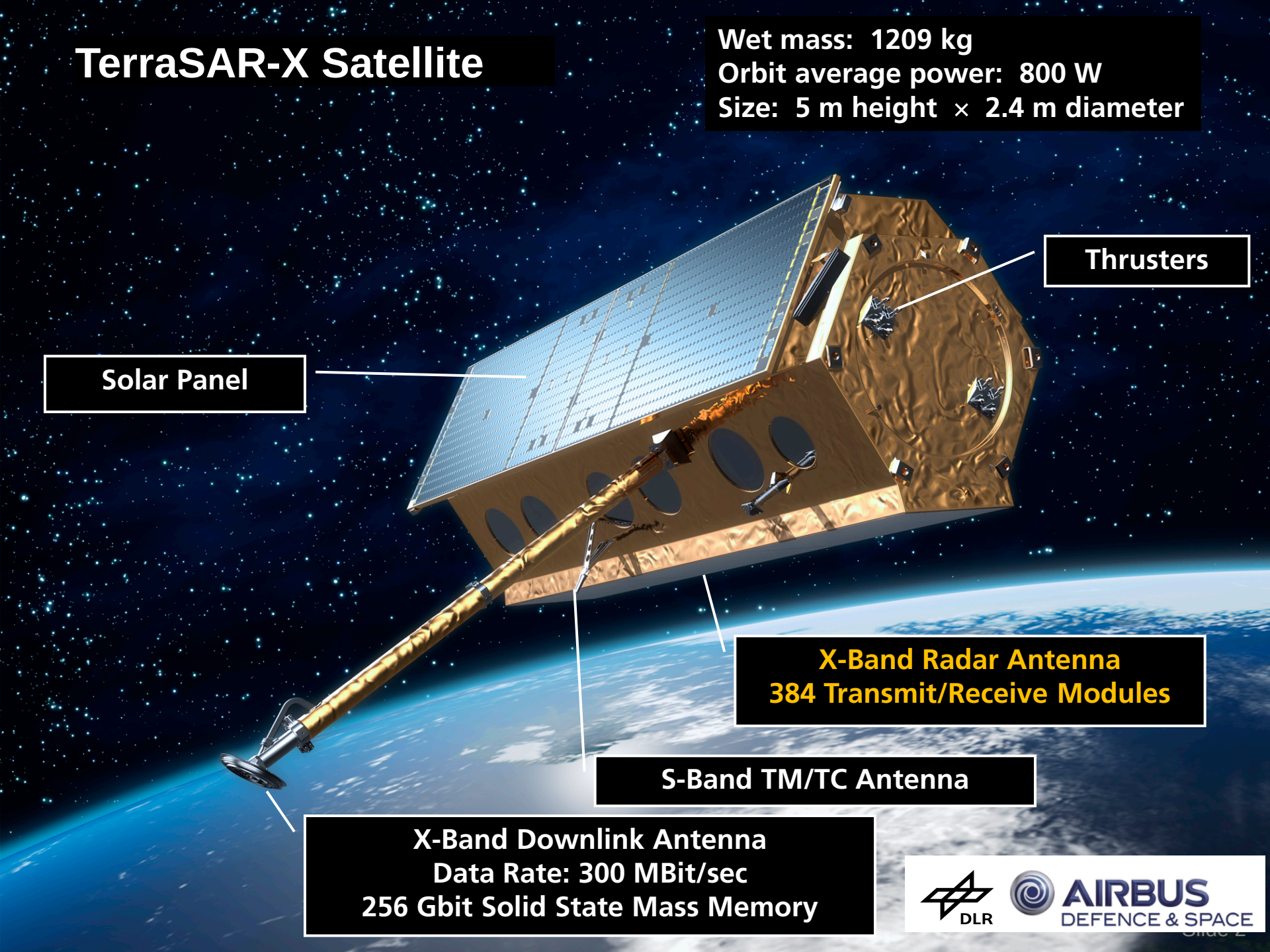
and TerraSAR-X / TanDEM-X Team

Microwaves and Radar Institute, DLR

DLR

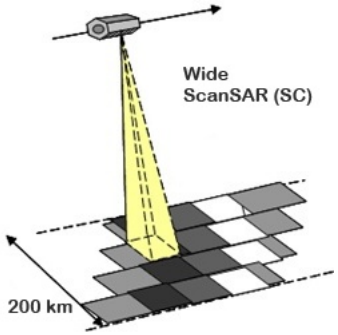
TerraSAR-X Satellite

Wet mass: 1209 kg
Orbit average power: 800 W
Size: 5 m height × 2.4 m diameter



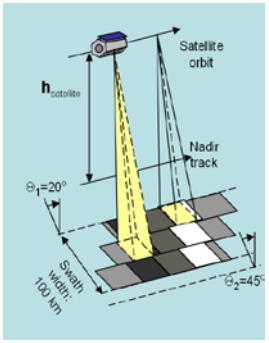
DLR AIRBUS DEFENCE & SPACE

TerraSAR-X Acquisition Modes



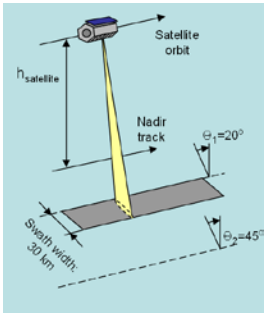
ScanSAR
(6 Beams)

7 x 40 m
200 x 200 km



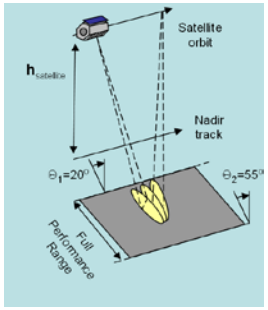
ScanSAR
(4 Beams)

2 x 18.5 m
100 x 150 km



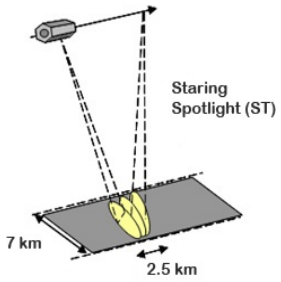
Stripmap

2 x 3.3 m
30 x 50 km



Sliding
Spotlight
(SL/HS)

2/1 x 1.7/1.1 m
10 x 10/5 km



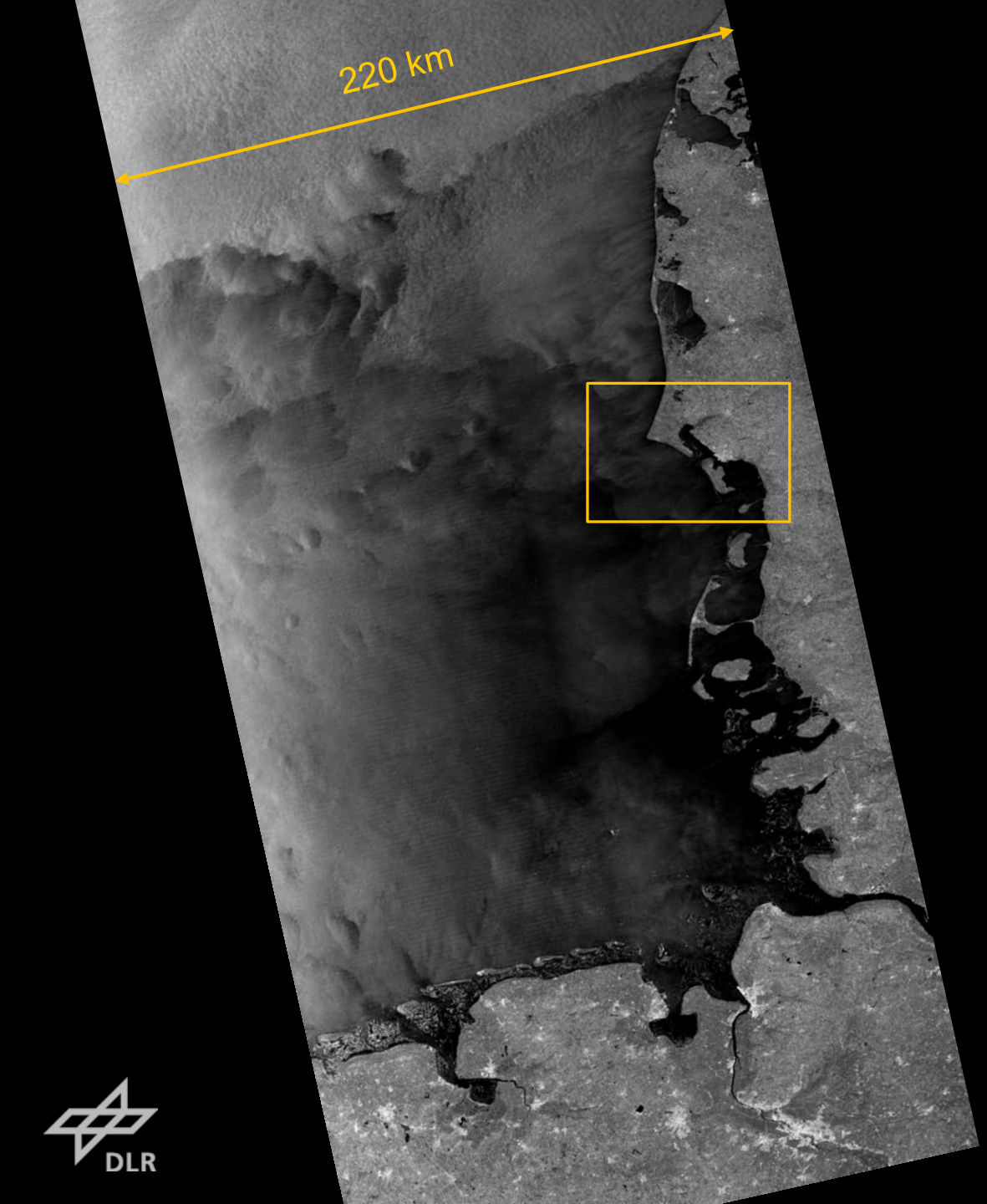
Staring
Spotlight

1 x 0.24 m
2.5 x 5 km

Scene Size (Rg x Az), m

Resolution (Rg x Az), m

2 new modes operational since mid 2013



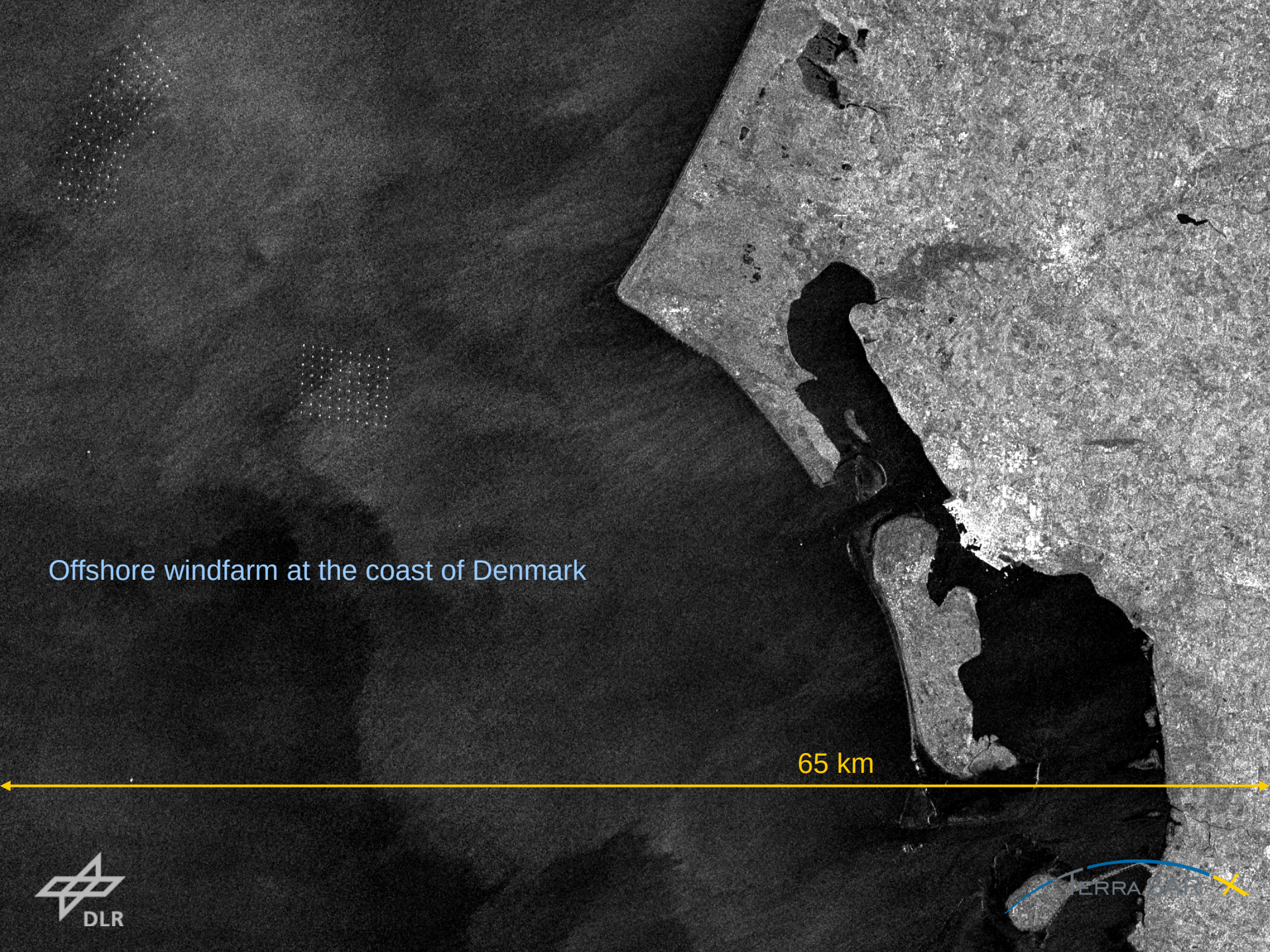
Wide ScanSAR

German Bight

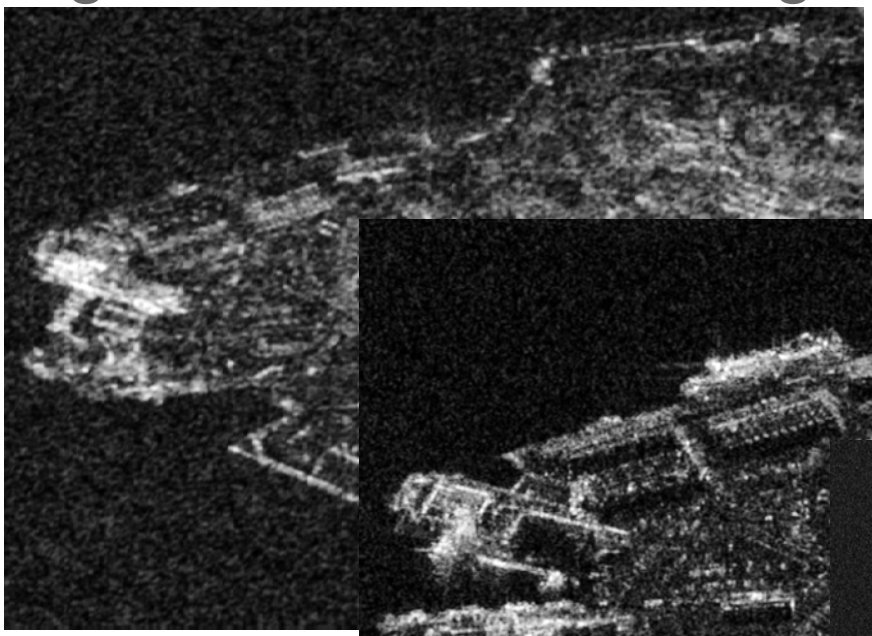
220 km × 500 km

DLR

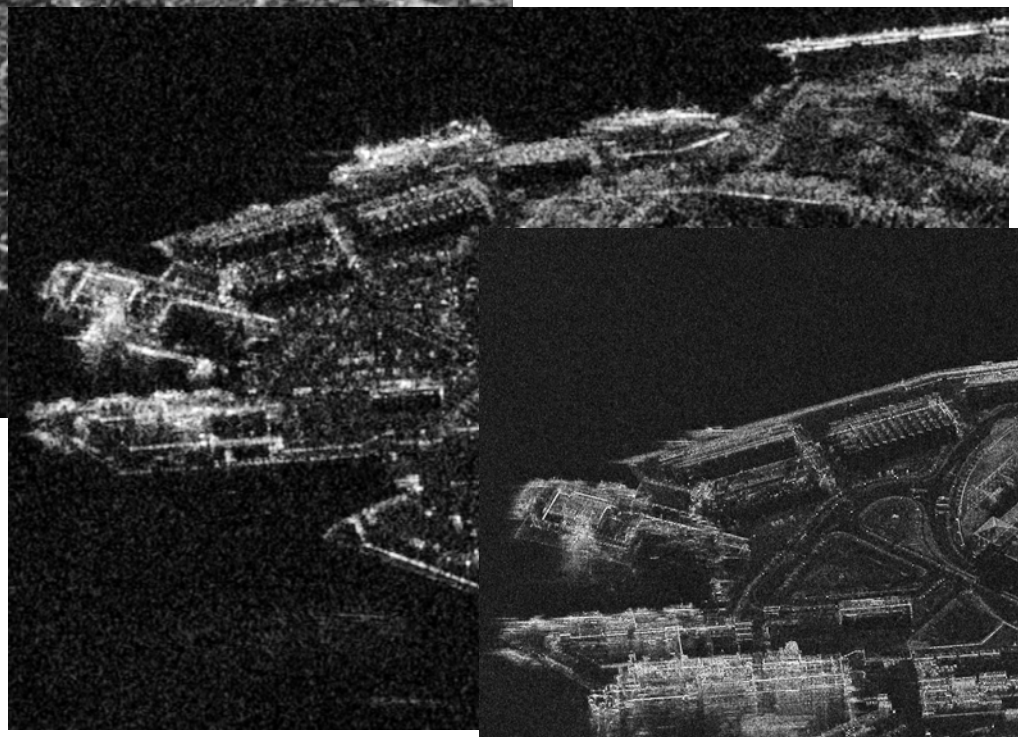
TerraSAR-X


Offshore windfarm at the coast of Denmark
65 km

High Resolution SAR Imaging with TerraSAR-X

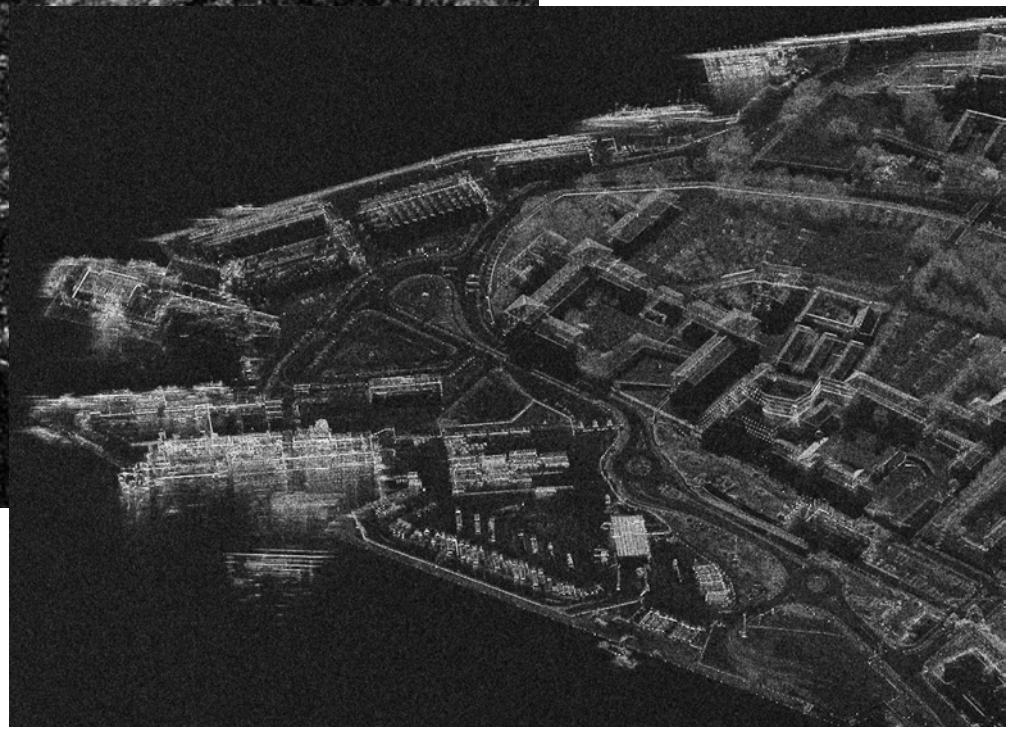


Stripmap



Sliding-Spotlight

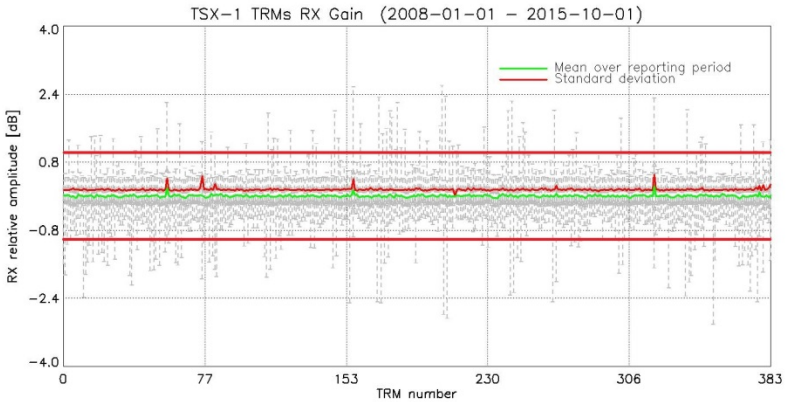
Staring-Spotlight



SAR Instrument Status: T/R Modules

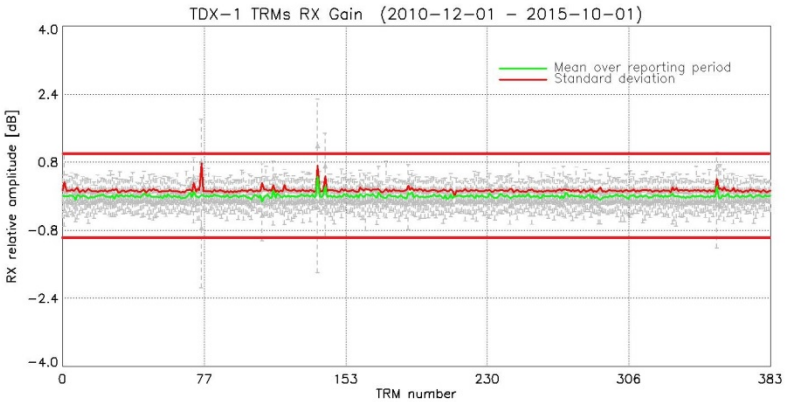
- Both TSX-1 and TDX-1 instruments show very stable operation since launch
- T/R Modules perform well within the requirements

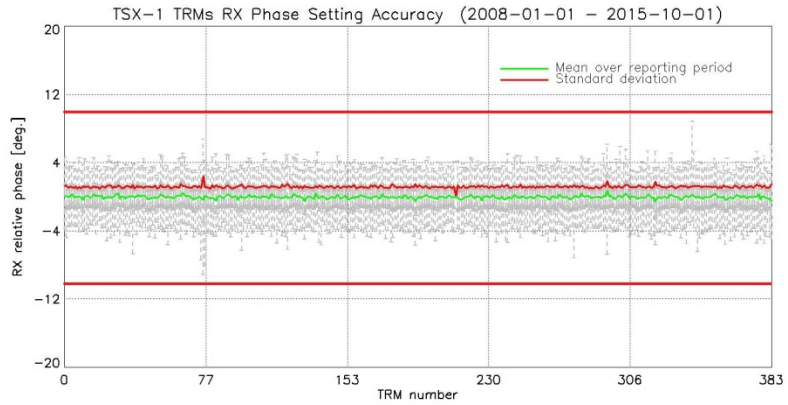
TSX-1



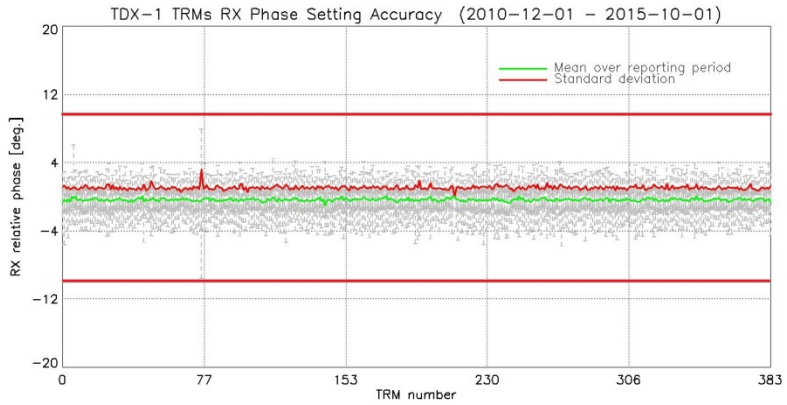
Rx Amplitude deviation

TDX-1



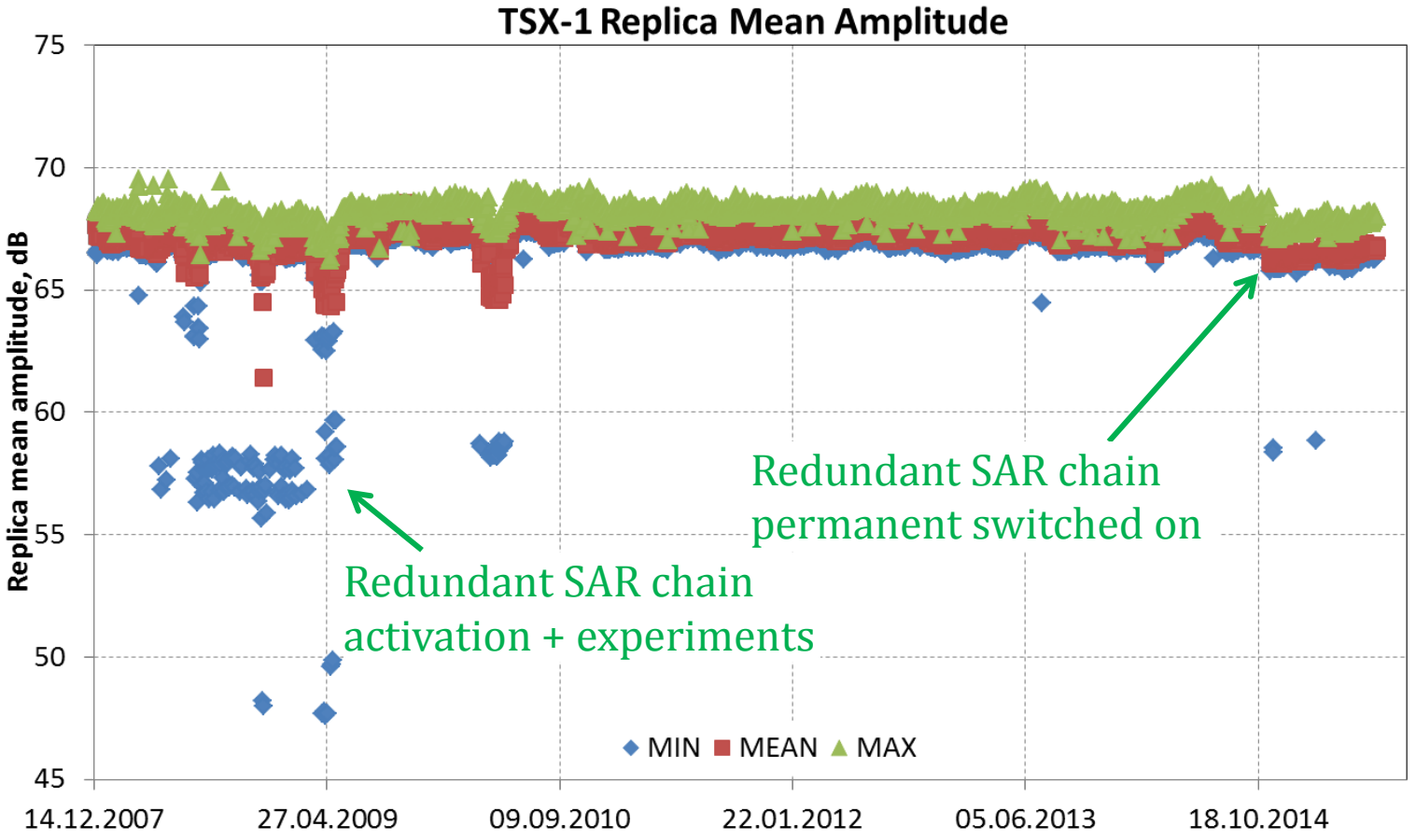


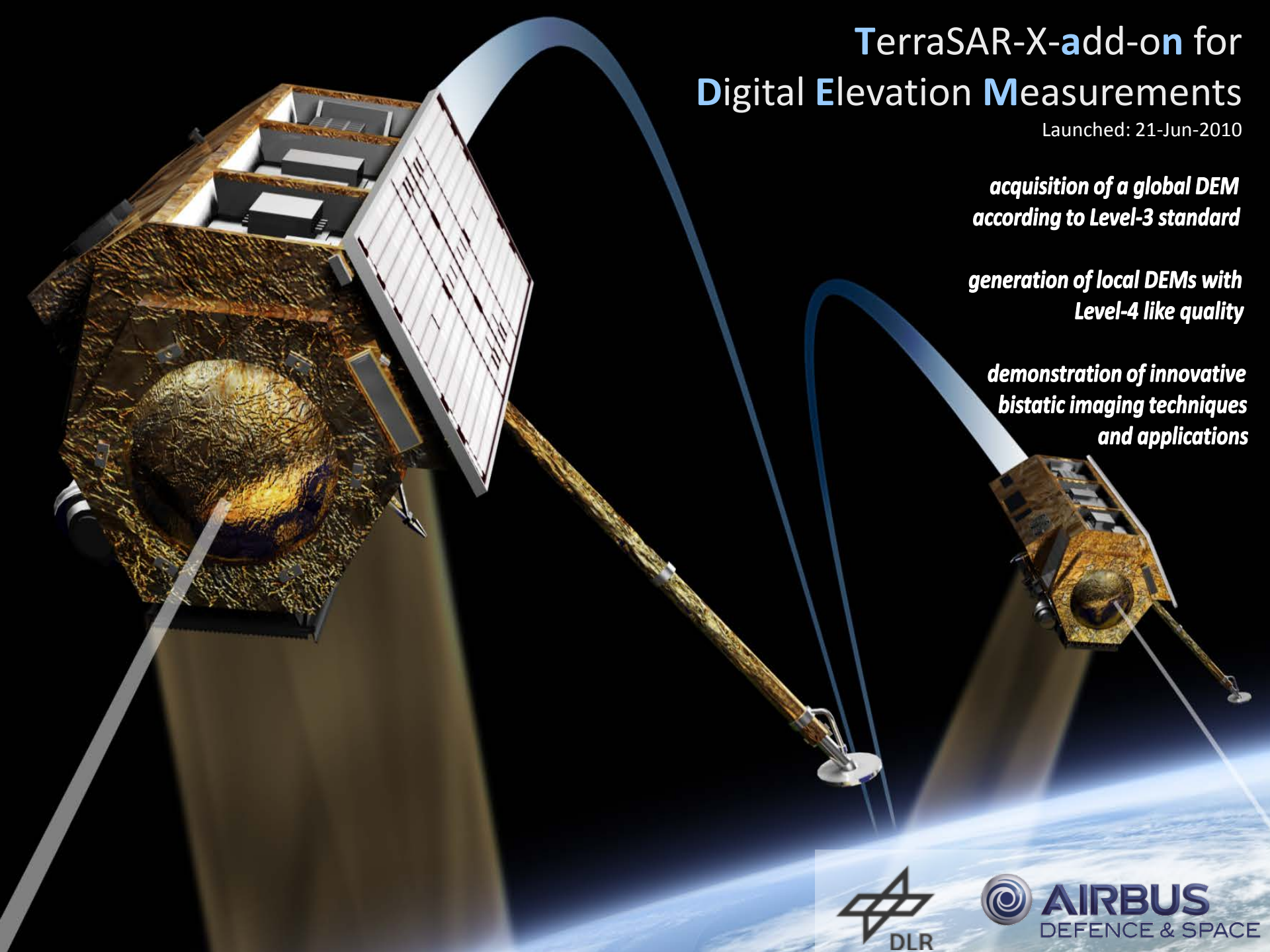
Rx Phase deviation



SAR Instrument Status: Gain

- Both TSX-1 and TDX-1 instruments show very stable operation since launch
- T/R Modules perform well within the requirements
- Instrument Total Gain shows normal behaviour

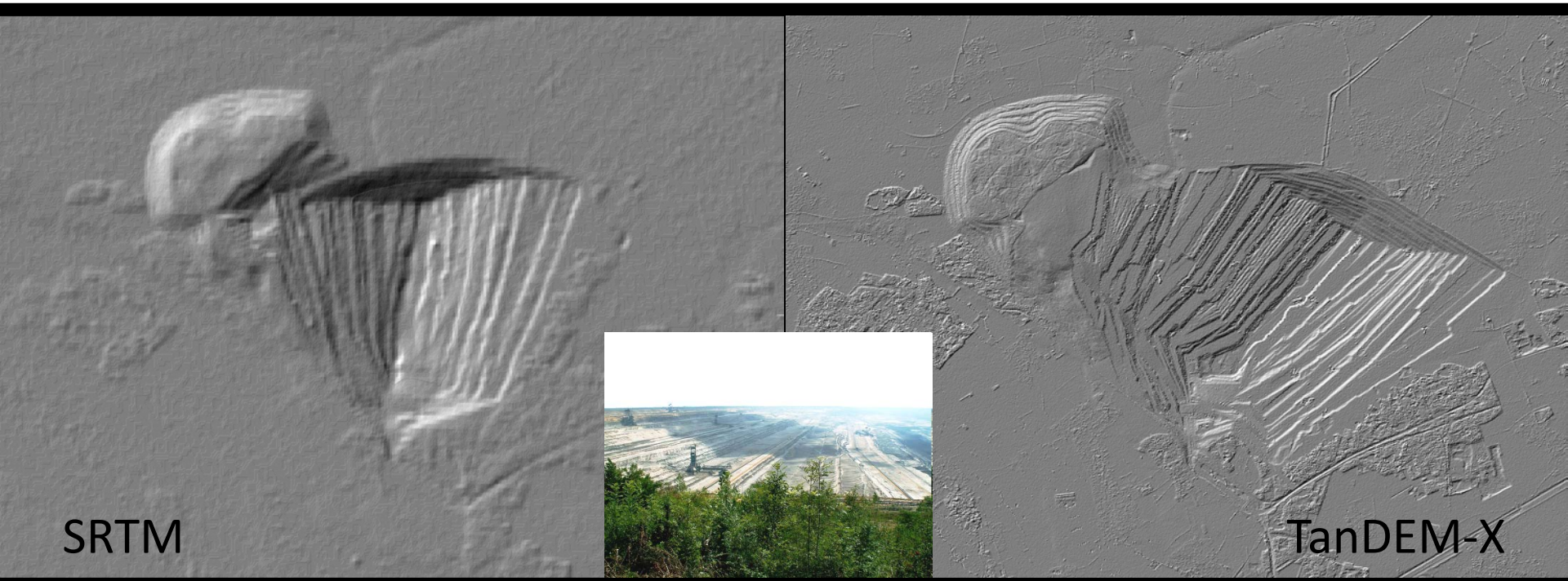



TerraSAR-X-add-on for
Digital Elevation Measurements
Launched: 21-Jun-2010
acquisition of a global DEM
according to Level-3 standard
generation of local DEMs with
Level-4 like quality
demonstration of innovative
bistatic imaging techniques
and applications
DLR
AIRBUS
DEFENCE & SPACE

Standards for Digital Elevation Models

* slopes below/above 20%

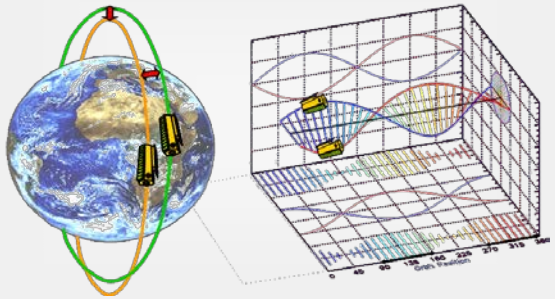
	Spatial Resolution	Absolute Vertical Accuracy (90%)	Relative Vertical Accuracy (point-to-point in 1° cell, 90%)
DTED-1	90 m x 90 m	< 30 m	< 20 m
DTED-2	30 m x 30 m	< 18 m	< 12 m
TanDEM-X	12 m x 12 m	< 10 m	< 2 m / 4 m *
Level-4	6 m x 6 m	< 5 m	< 0.8 m



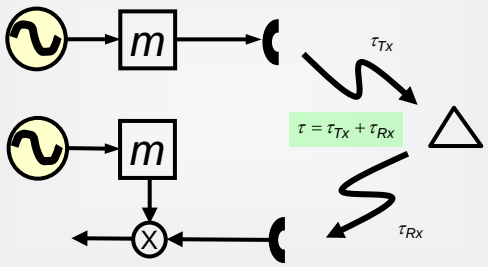
Coal Mine Hambach - Germany

TanDEM-X Challenges

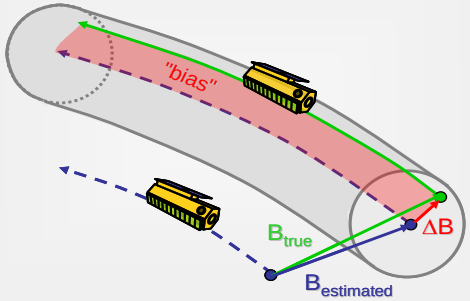
Safe Formation Flying



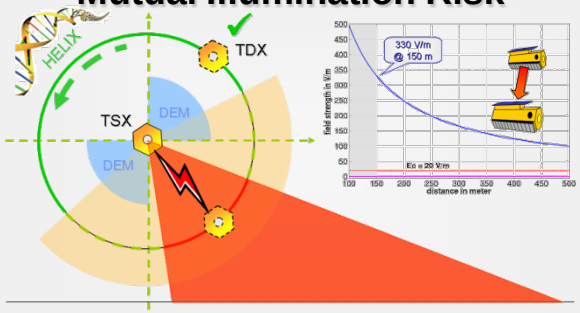
Synchronisation



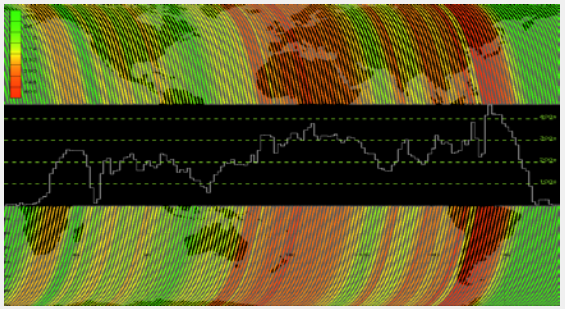
3-D Baseline Estimation



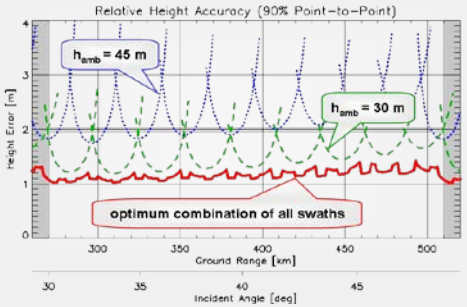
Mutual Illumination Risk



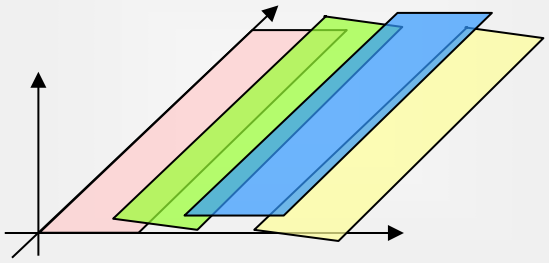
Ressource Management



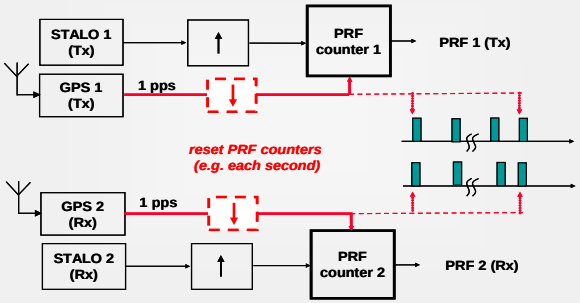
Performance Optimization



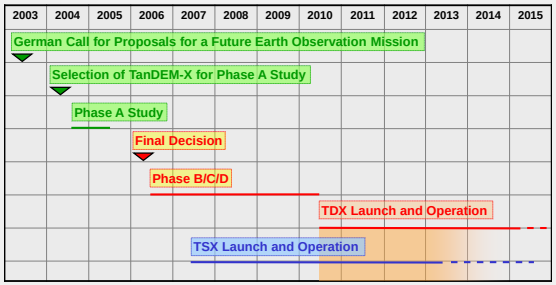
DEM Calibration



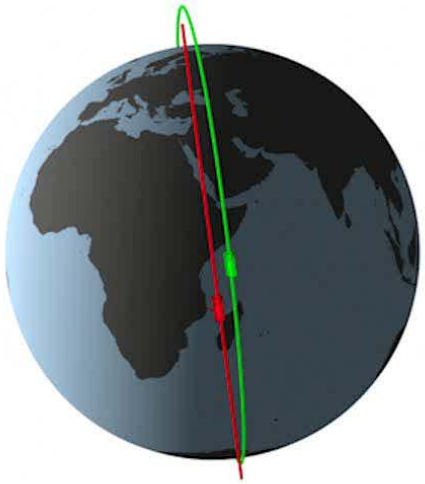
Commanding

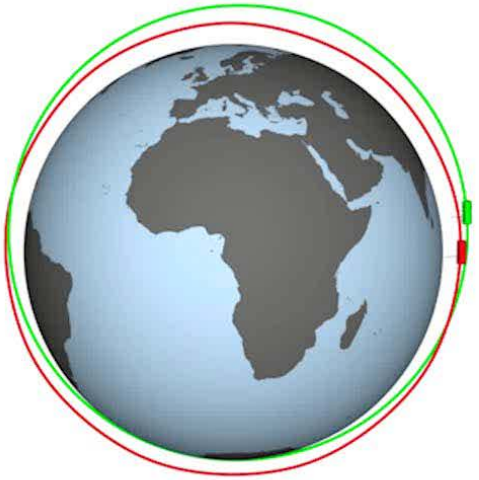


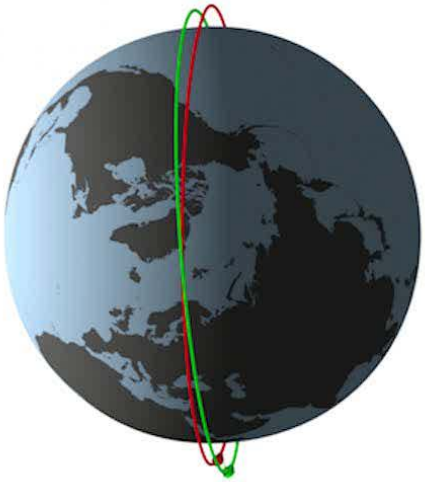
Schedule

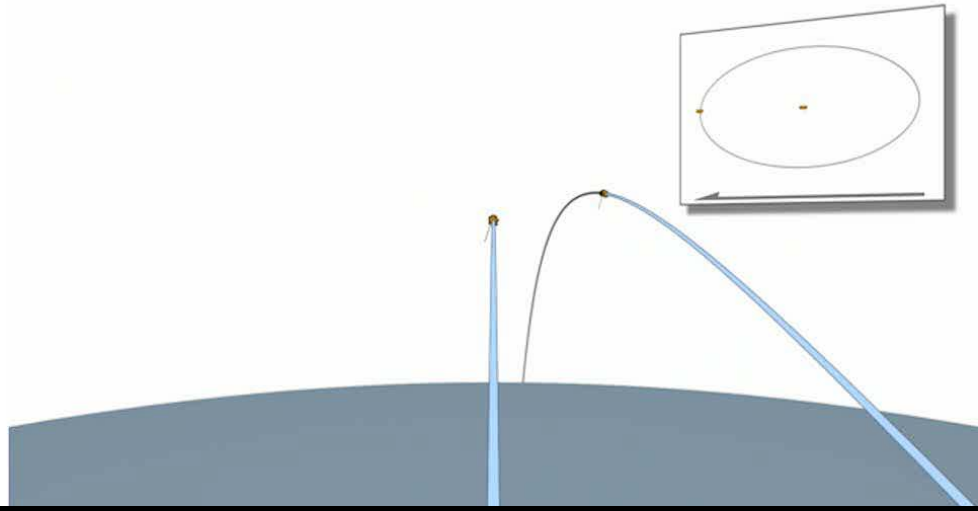


Helix Formation

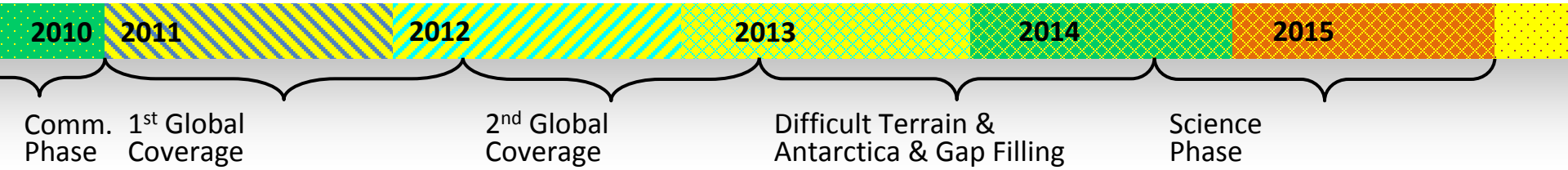








TanDEM-X Global DEM Acquisition Plan



1st Global Coverage

- Small baseline (~200 m)
- Height of Ambiguity ~ 50 m

3rd Year

- Antarctica
- Difficult terrain to account for shadow & layover
  → Different viewing geometry
- Deserts

2nd Global Coverage

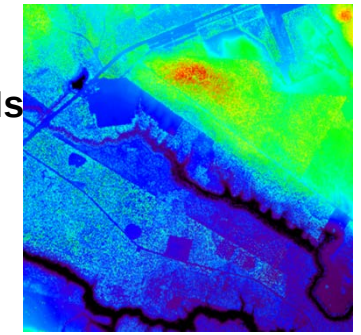
- Increased baseline (~300 m)
- Height of Ambiguity ~ 35 m

Combination:

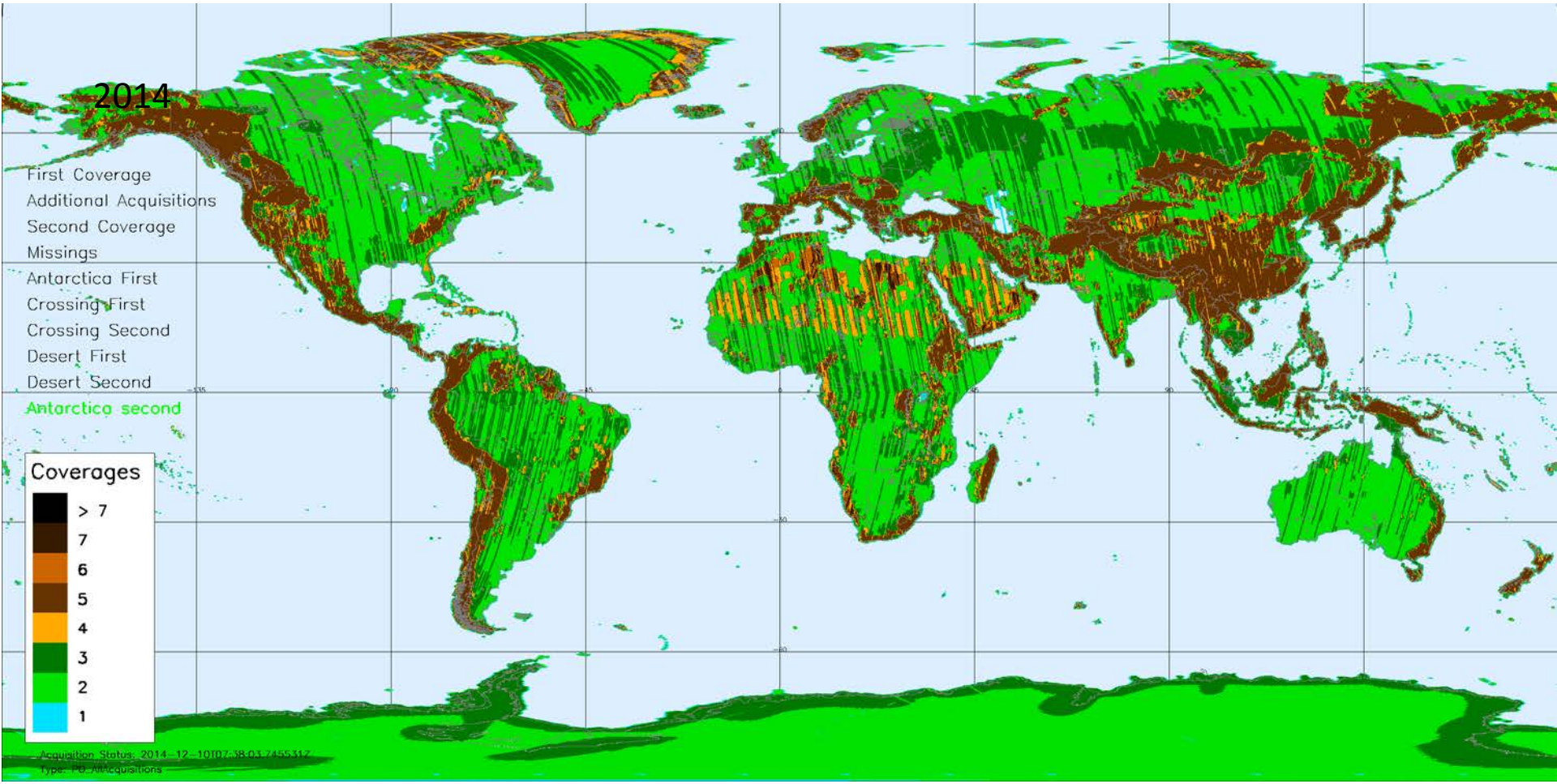
- Dual Baseline Phase Unwrapping
- Improved relative height accuracy

4th Year & Beyond

- **TanDEM-X Science Phase**
- **Local High-Resolution DEMs**
- Global DEM improvement &
- Complementary products

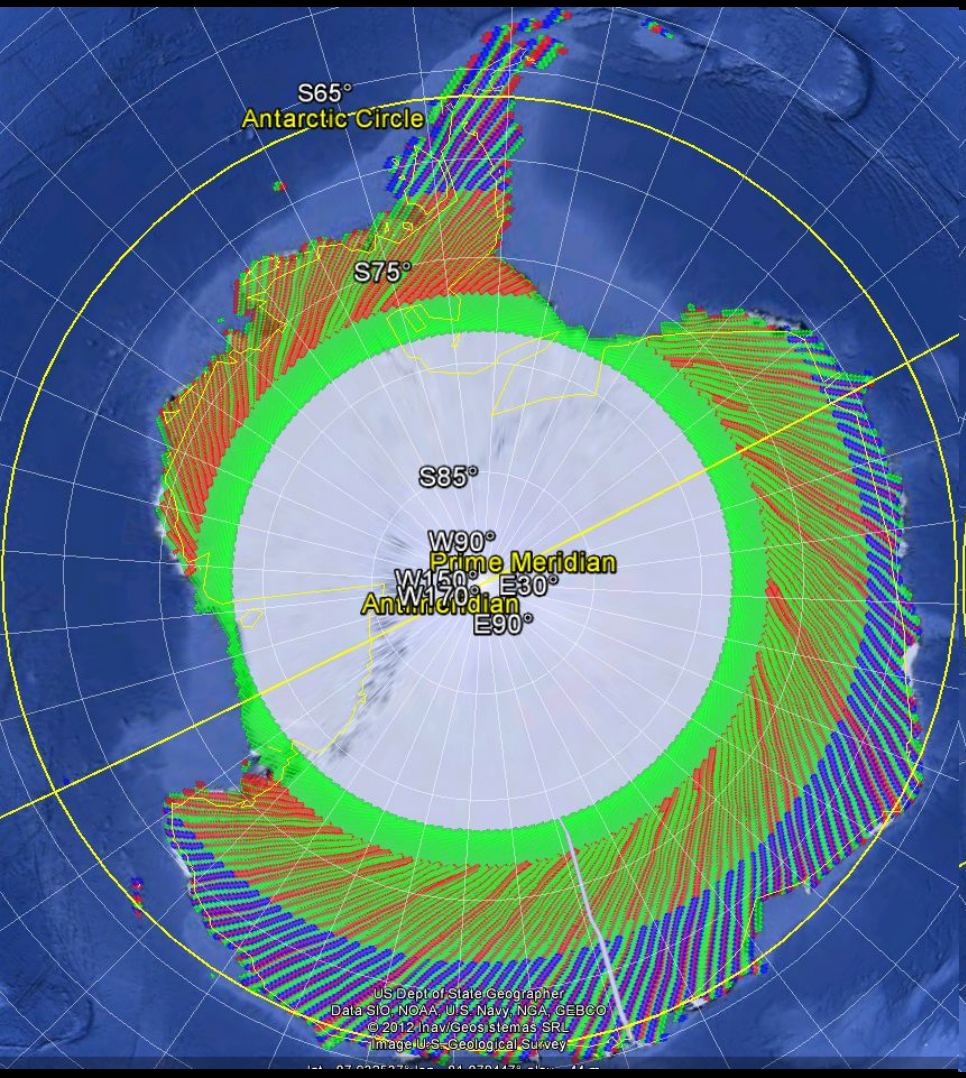


Coverages on the Global Map: 2010-2014(5)

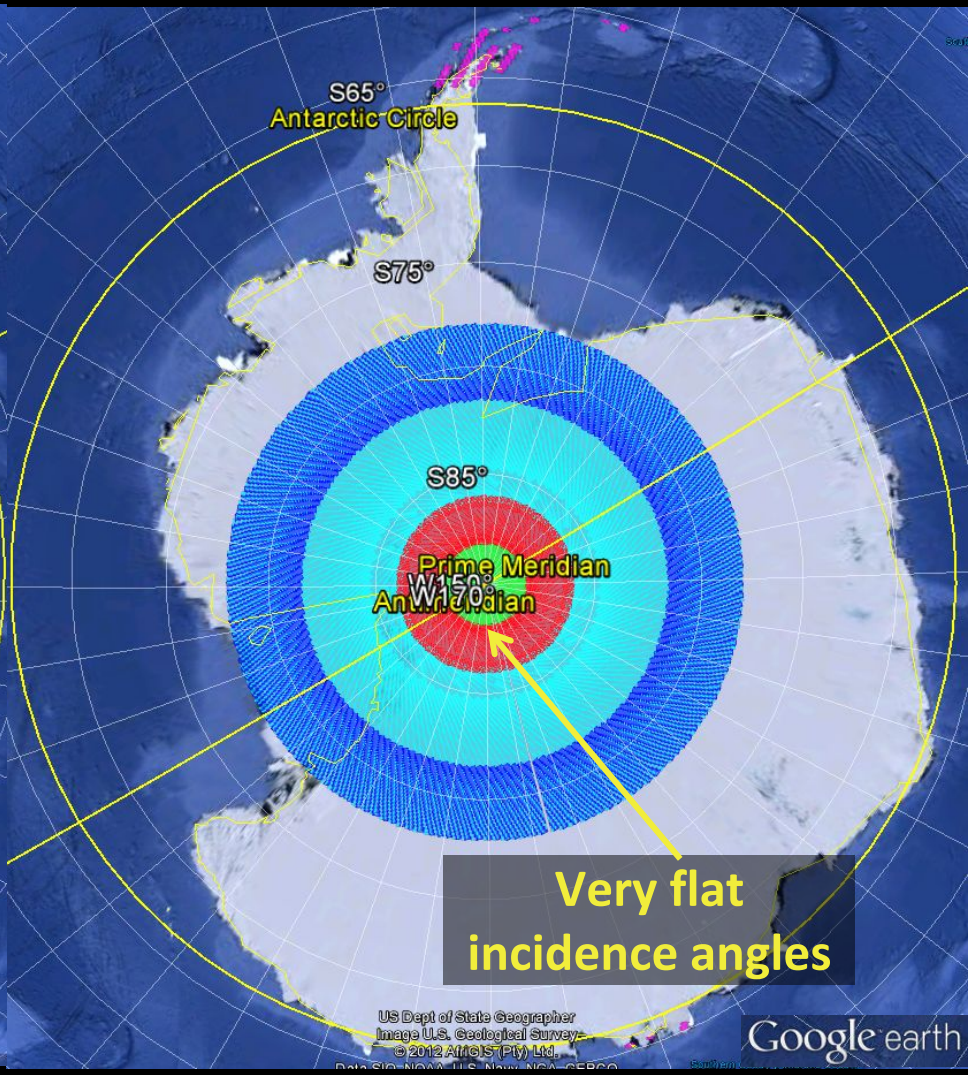


3rd Year Antarctica Acquisitions – May - July 2013 + 2014

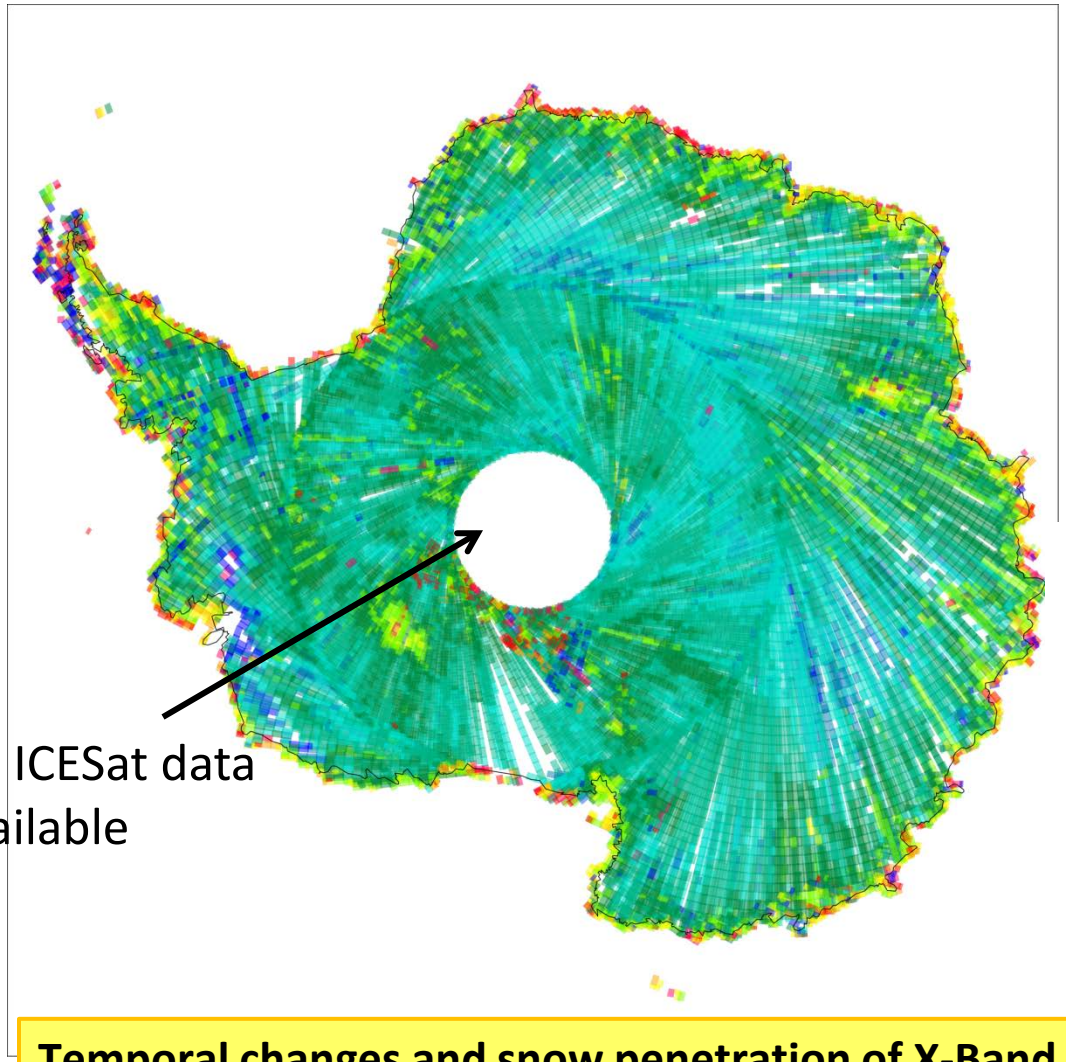
Right-Looking



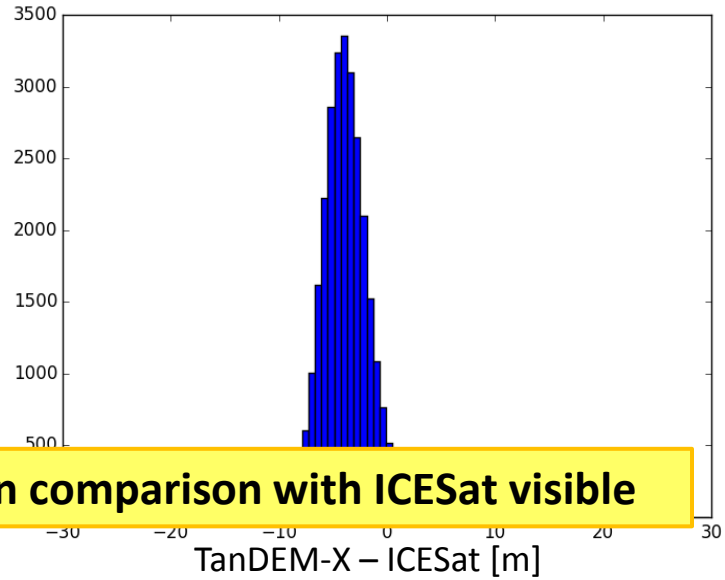
Left-Looking



RawDEMs over Antarctica vs ICESat: Preliminary Results



No ICESat data available



Temporal changes and snow penetration of X-Band in comparison with ICESat visible

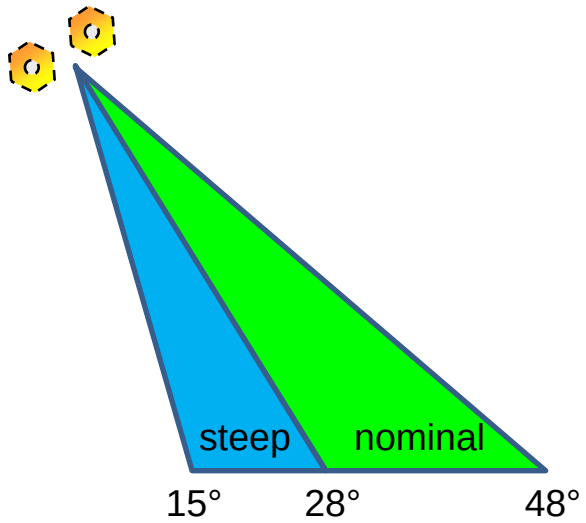
Acquisition of Sandy Deserts

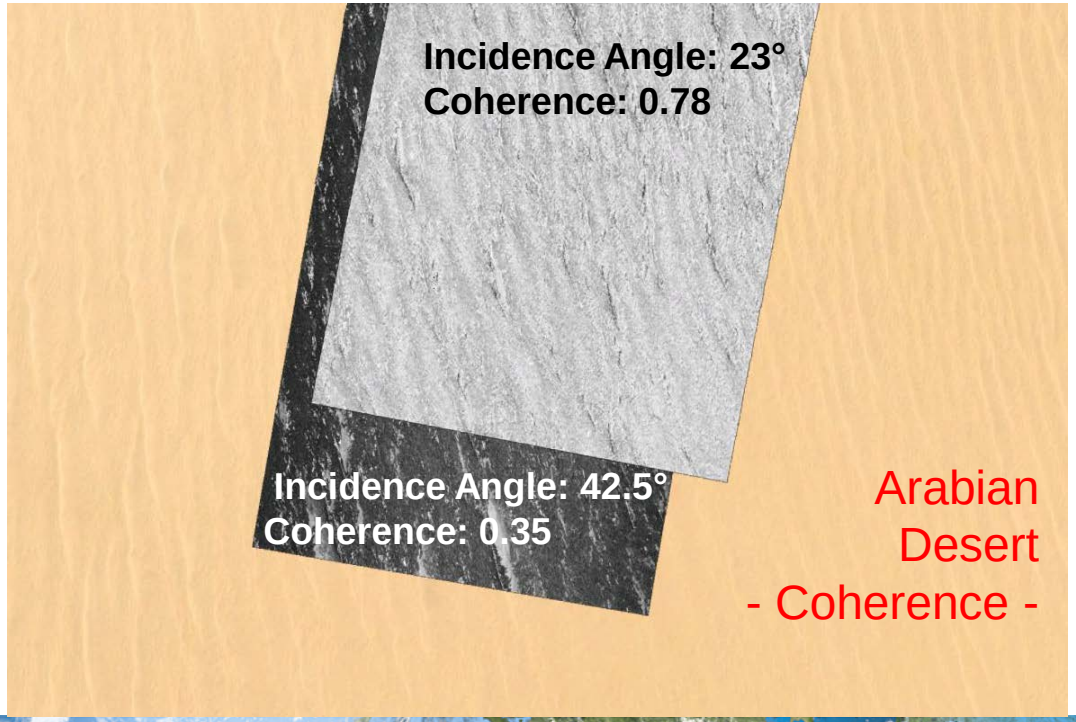
Sandy Deserts

- low backscatter → low coherence → high rel. height error
- Smaller incidence angles: 15º - 28º (nominal 28º – 48º)

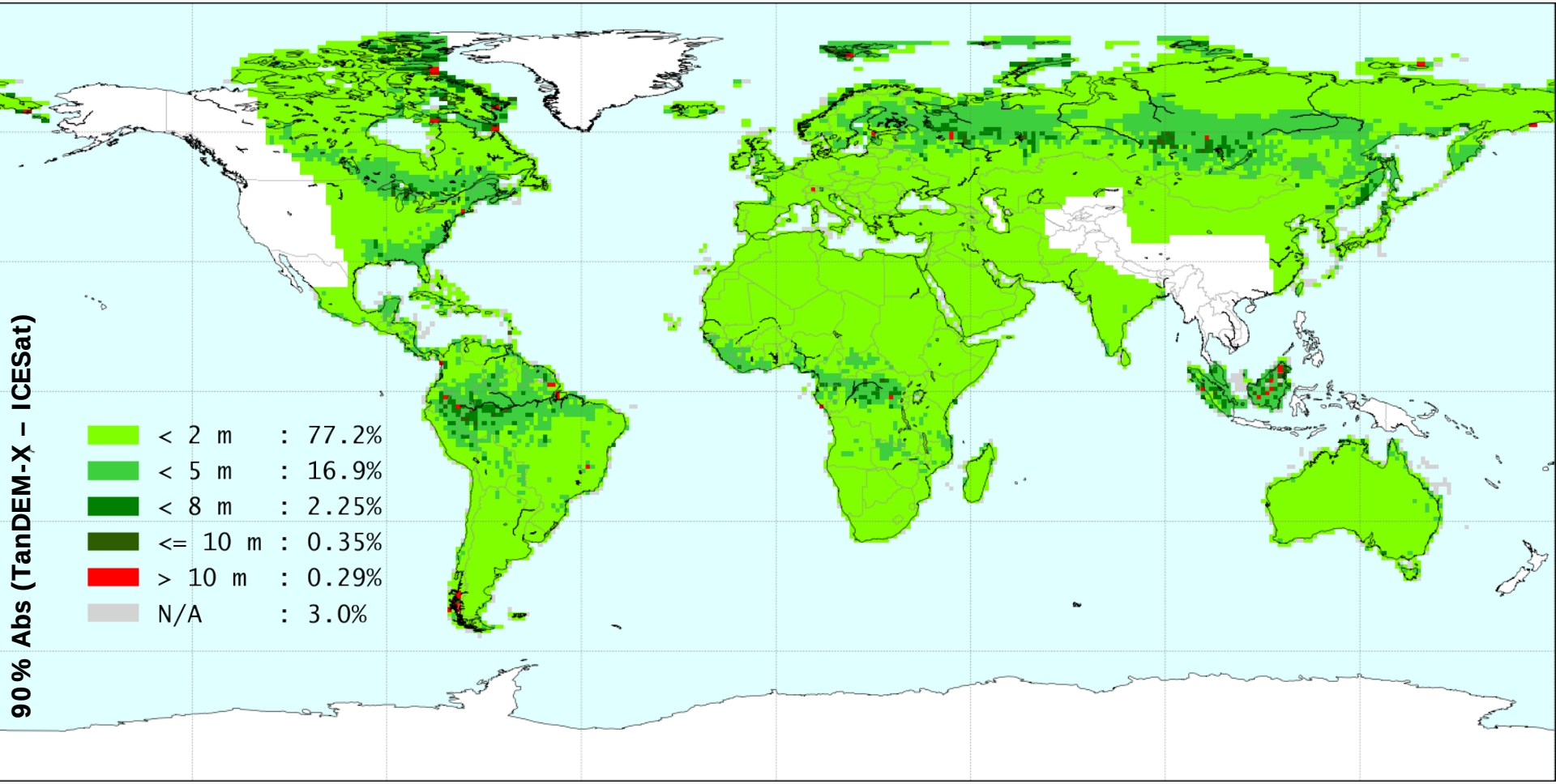
Sandy Deserts with topography

- acquisition with different viewing geometry as for mountainous regions



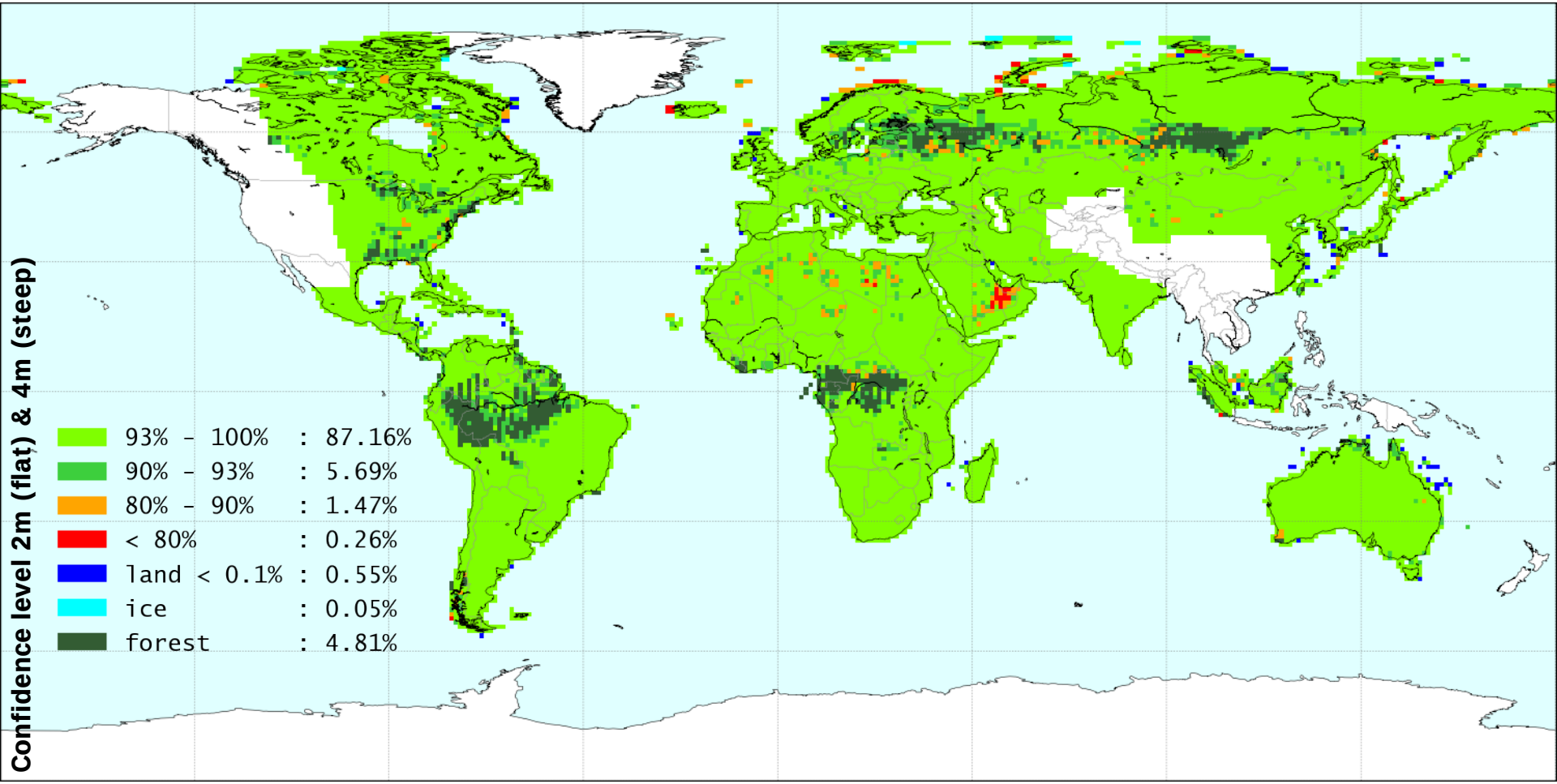


Final DEM – Absolute Height Accuracy



99.7 % of the Tiles have 10 m or better 90 % Linear Accuracy
Accumulated Absolute Height Accuracy with 90% Linear Error: **1.13 meters**

Final DEM – Relative Height Accuracy

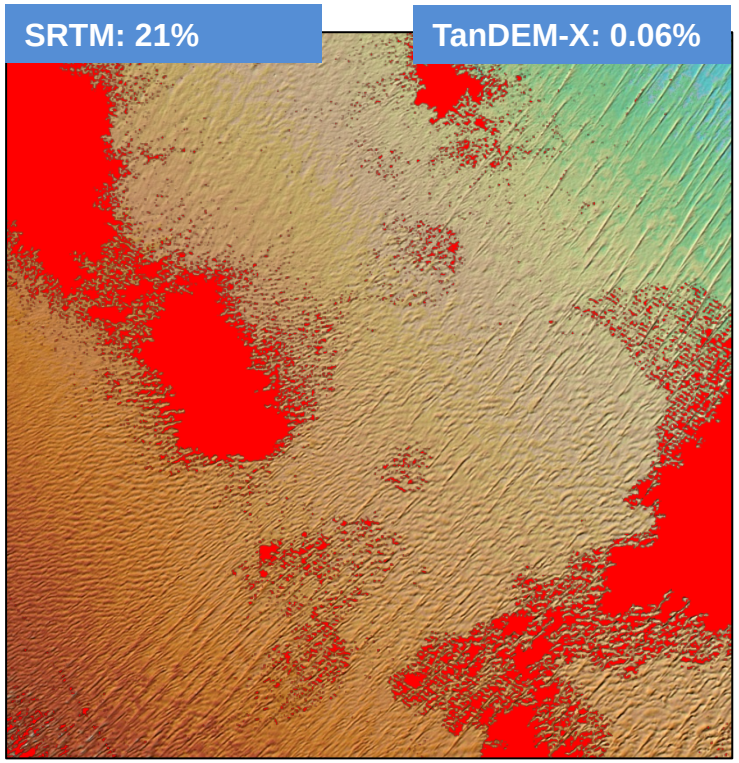


98.6% of Final DEMs Achieve Relative Height Accuracy Specification (2m/4m)

Data Coverage: Comparison with SRTM Rev. 1.0

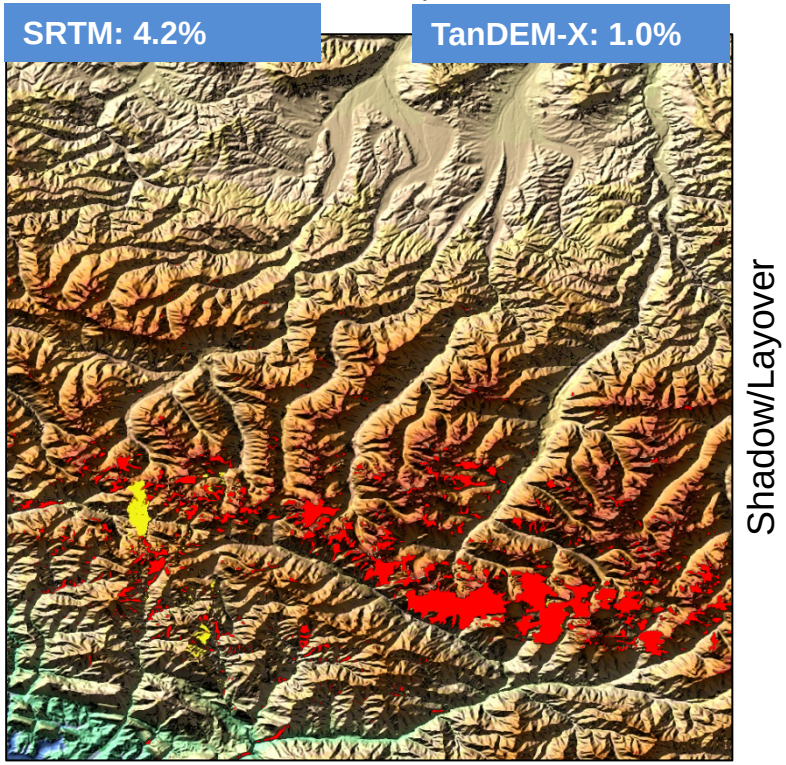
- Voids occur when:
  - No data was available for example, Shadow/Layover or missing coverage
  - The data has too poor quality for example, low signal return
  - The pixel is over water

Percent Invalid per Tile



N20E051: Saudi Arabia

Percent Invalid per Tile



N43E041: Caucasus Mountains

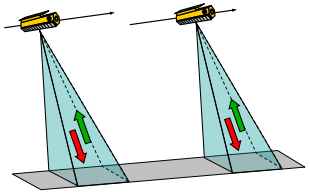
TanDEM-X Science Phase

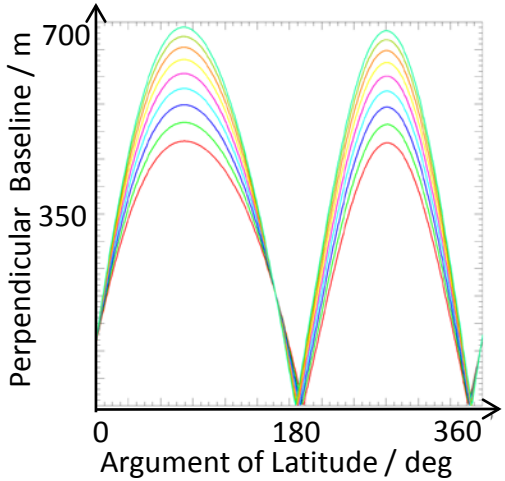
- 15 months duration (October 2014 … December 2015)
- Dedicated to the demonstration of innovative techniques and experiments (secondary mission objective of the TanDEM-X mission)
- Link: **https://tandemx-science.dlr.de**

Formation Configuration during the Science Phase

Oct 2014 –Feb 2015

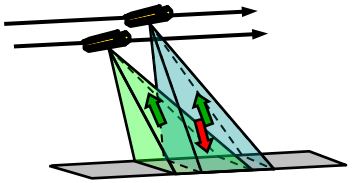
Pursuit monostatic
76 km along-track
Satellite drift in 104 days

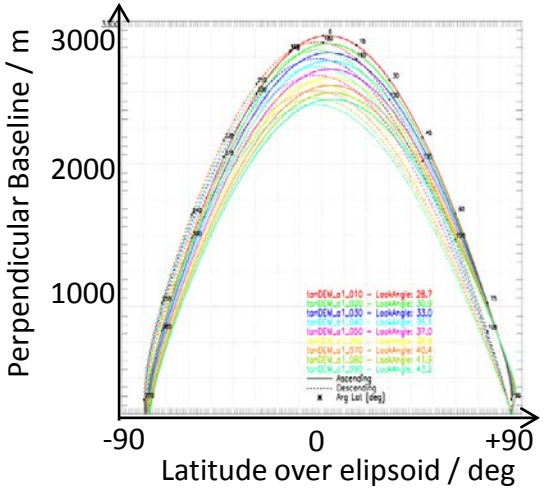




Mar – Aug 2015

Large bistatic
~ 3.6 km cross-track at the equator





Sept –Dec 2015

Close bistatic
Small along-track
Southern Hemisphere

Challenges in large bistatic:
- Spectral Shift
- Synchronization Link
- Timeline Schedule
- Load on TerraSAR-X

from Dec. 2014: Dual Receive Antenna Mode

Mission Outlook

- 2016
  - Close bistatic formation with nominal formation parameters
  - TerraSAR-X: continuing operations with both satellites
  - TanDEM-X: global DEM expected to finish in autumn 2016
  - TanDEM-X: further science and HDEM acquisitions

- Agreement between DLR and AIRBUS D&S for mission continuation beyond 2016

- Based on available onboard resources operation up to 2020 predicted for both satellites

- Interested in products:
  - TerraSAR-X Science Portal: **http://sss.terrasar-x.dlr.de/**
  - TanDEM-X Science Portal: **https://tandemx-science.dlr.de/**